COMPUTING AND INFORMATION SCIENCE

ADMINISTRATION

Robert Constable, dean

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INTRODUCTION

Computing and Information Science (CIS) offers courses and programs campuswide in various academic disciplines in which computing is integral. It is home to the Department of Computer Science, the Department of Statistical Science, the program in Information Science, and interdisciplinary programs in computational biology, computational science and engineering, game design, and computing in the arts. The faculty members associated with CIS programs hold joint appointments with CIS and another Cornell academic unit.

Computing and Information Science is a rapidly changing area. Please consult the CIS web site, www.cis.cornell.edu, for the most current news of programs and courses, or visit the CIS undergraduate office in 303 Upson Hall.

ACADEMIC PROGRAMS

Computing and Information Science offers the following academic programs through its corresponding colleges. See the departmental listings for details of the programs.

Computational Biology

The program of study in computational biology is part of the biological sciences major offered through the College of Agriculture and Life Sciences and the College of Arts and Sciences and is coordinated by the Office of Undergraduate Biology. It provides core training in biology and the supporting physical and information sciences. It is designed for students who want to emphasize basic biological science.

The concentration in computational molecular biology is offered by the Department of Computer Science to students enrolled in the College of Arts and Sciences and the College of Engineering. It provides core training in computer science and biology. It is designed for students who want to emphasize computational science.

The concentration in statistical genomics is offered by the Department of Biological Statistics and Computational Biology to students enrolled in the College of Agriculture and Life Sciences. It provides training in statistics, biology, and computer science. It is designed for students who want to emphasize statistics and bioinformatics.

The concentration in mathematical biology is offered by the Department of Mathematics and is open to students enrolled in the College of Arts and Sciences. It provides training in mathematics, biology, and computer science. It is designed for students who want to emphasize mathematics.

Computational Science and Engineering

Computational science and engineering is an emerging CIS program. Numerous courses are taught throughout the university. Topics include numerical methods, modeling and simulation, and real-time computing and control.

Computer Science

All CIS programs have connections to computer science, the study of computation in all of its forms. The curriculum covers the theory of algorithms and computing and its many applications in science, engineering, and business. Students learn the algorithmic method of thinking and how to bring it to bear on a wide range of problems. They also study the elements of computing and information technology such as system design, problem specification, programming, system analysis and evaluation, and complex modeling. Research areas include programming languages and compilation, computing systems, artificial intelligence, natural language processing, computer graphics, computer vision, databases and digital libraries, networks, bioinformatics, the theory of algorithms, scientific computing, computational logic, architecture, and security.

The Department of Computer Science offers the computer science major to students in the College of Arts and Sciences and the College of Engineering, the computer science minor to students across colleges, and the Master of Engineering (M.Eng.) degree in computer science.

Minors

Students may pursue minors in any department in any college that offers them, subject to limitations placed by the department offering the minor or by the student's major. Completed minors will appear on the student's transcript. Not all departments offer minors. Consult the appropriate section in this catalog or contact the appropriate department for information on minors offered and how to pursue a minor.

Computing in the Arts

An undergraduate minor in Computing in the Arts offers students opportunities to use computers to realize works of art, to study the perception of artistic phenomena, and to think about new, computer-influenced paradigms and metaphors for the experiences of making and appreciating art. Faculty from several departments across the university offer courses toward the minor, drawing on disciplines in the arts, computing, the social sciences, the humanities, and the physical sciences. Tracks are available for students pursuing this minor in: computer science, music, psychology, dance, and film. This minor is offered through the College of Arts and Sciences and coordinated by the Department of Computer Science. Students across colleges are eligible to pursue this program of study.

Game Design

The undeniable popularity of games draws the attention of academia, industry, and even the government on areas of design, development, and social impact. The game industry, like the film industry, is an unmistakable force in entertainment. Like filmmaking, game design can thrive and evolve only with the support of a strong academic foundation. The Game Design minor is offered by the Department of Computer Science for students who anticipate that game design will have a prominent role to play in their academic and professional career. Overwhelming interest also sparked the creation of the Game Design Initiative at Cornell University (GDIAC) in 2003. This organization is a group of students, faculty, alumni, and community members who are devoted to the establishment of game design as an academic discipline. Students across colleges are eligible to pursue the Game Design minor.

Information Science

The interdisciplinary program Information Science studies the design and use of information systems in a social context. It integrates the study of three aspects of digital information systems. First, information science studies computing systems that provide people with information content; this study overlaps with parts of computer science, stressing the design, construction, and use of large information systems such as the World Wide Web and other global information resources. The second aspect of information science examines how people engage these information resources and how they can be integrated into everyday life. This area is also called "human-centered systems" because it is concerned with systems that hundreds of millions of people will use in daily life. The third aspect deals with understanding how information systems are situated in social, economic, and historical contexts. It explores the economic value of information, the legal constraints on systems, their social impact, and the cultural aspects of their construction. These are synergistic topics, and the next generation of scientists, scholars, business leaders, and government workers will need to understand them and how they relate.

Specific topics emphasized in the information science program include information networks; information discovery; knowledge organization; interaction design; interface design and evaluation; collaboration within and across groups, communities, organizations, and society; computational linguistics; computational techniques in the collection, archiving, and analysis of social science data; information privacy; methods of

collecting, preserving, and distributing information; information system design; cognition and learning; social informatics; and cultural studies of computation.

The Information Science (IS) major is offered by the College of Agriculture and Life Sciences and the College of Arts and Sciences. Students in the College of Engineering may major in Information Science, Systems, and Technology (ISST), which is offered jointly by the Department of Computer Science and the School of Operations Research and Information Engineering. For details about the IS and ISST majors, please refer to the respective colleges.

The minor in information science is available to students in all undergraduate colleges.

Statistical Science

The university-wide Department of Statistical Science coordinates activities in statistics and probability at the undergraduate, graduate, and research levels.

The department is organized into four units: Biological Statistics, Engineering Statistics, Mathematical Statistics and Probability, and Social Statistics. The areas covered include agricultural statistics, biostatistics, economic and social statistics, epidemiology, manufacturing statistics, quality control and reliability, probability theory, sampling theory, statistical computing, statistical design, statistical theory, and stochastic processes and their applications.

The department offers an undergraduate major and minor in Biometry and Statistics through the Department of Biological Statistics and Computational Biology in the College of Agriculture and Life Sciences. It also offers a minor in Engineering Statistics through the School of Operations Research and Information Engineering in the College of Engineering. Undergraduate majors and minors are under development for other colleges. For information, contact the undergraduate coordinator, 301 Malott Hall, 255-8066.

Students interested in graduate study in statistics and probability can apply to the graduate field of statistics or to one of the other graduate fields of study that offer related course work. Students in the field of statistics plan their graduate programs with the assistance of their special committee. For detailed information on opportunities for graduate study, contact the director of graduate studies, 301 Malott Hall.

The department offers a Master of Professional Studies (MPS) in applied statistics for students pursuing careers in business, industry, and government. The MPS program has three main components: a two-semester core course, STSCI 5010 and 5020, covering a wide range of statistical applications, computing, and consulting; an in-depth statistical analysis MPS project supported by the core course; and required course work, including a two-semester course sequence in mathematical probability and statistics, and elective course work selected from offerings in this and other departments at Cornell. The M.P.S. program offers two options: Statistical Analysis and Data-Centered Systems.

A statistical consulting service is offered by the faculty of DSS and the Cornell Statistical Consulting Unit (CSCU), 255-1926. There is no charge to members of the Cornell community for using the Statistical Consulting Service. It provides guidance to researchers in a broad variety of fields on designing experiments, collecting and analyzing data, and drawing appropriate conclusions from the results of their studies. Statistical computing consulting is also available through the Office of Statistical Consulting, B21 Savage Hall, 255-1926.

THE INFORMATION SCIENCE MINOR

A minor in information science is available to students in the Colleges of Agriculture and Life Sciences; Architecture, Art, and Planning (available to Architecture and Planning students only); Arts and Sciences; Engineering; Human Ecology; and the Schools of Hotel Administration and Industrial and Labor Relations. Because of small differences in regulations between the colleges, the requirements may vary slightly, depending on a student's college and, in a few cases, a student's major. Students interested in pursuing the information science minor must initiate the process by sending an e-mail message with their name, college, year of study (e.g., second-semester sophomore), expected graduation date, and (intended) major to minor@infosci.cornell.edu. See www.infosci.cornell.edu/ugrad.html for the most up-to-date description of the minor and its requirements.

Information science is an interdisciplinary field covering all aspects of digital information. The program has three main areas: human-centered systems, social systems, and information systems. Human-centered systems studies the relationship between humans and information, drawing from human-computer interaction and cognitive science. Social systems examines information in its economic, legal, political, cultural, and social contexts. Information systems studies the computer science problems of representing, storing, manipulating, and using digital information.

The minor has been designed to ensure that students have substantial grounding in all three of these areas. To this end, the requirements for the undergraduate minor are as follows: All courses must be chosen from the course lists below. In addition, a letter grade of at least C is required; S-U courses are not allowed.

Note: Course credits from institutions other than Cornell may not be counted toward the IS minor. Engineering students must use ENGRD 2700 or CEE 3040. Hotel students must use HADM 2201.

- **Statistics:** one course.
- **Human-centered systems** (human-computer interaction and cognitive science): two courses (for all colleges except Engineering and Hotel); one course (Engineering and Hotel).
- **Social systems** (social, economic, political, cultural, and legal issues): one course.
- **Information systems** (primarily computer science): two courses for all colleges except Hotel. Hotel students need to take one course in this area. Engineering students may not use INFO 1301 and 1302. CS 2110 may not be used by students who are required to take it for their major.
- **Elective:** one additional course from any component area. Hotel students must take three courses in this category, from the following: HADM 3374, 5574, and 4476. (Engineering students and all computer science majors must select a course from human-centered systems or social systems. Communication majors must select a course outside Communication. Students in other majors should check with their advisors to make sure there are no special departmental restrictions or requirements.)

Statistics

An introductory course that provides a working knowledge of basic probability and statistics and their application to analyzing data occurring in the real world.

Engineering students must take one of the following:

- ENGRD 2700 Basic Engineering Probability and Statistics
- CEE 3040 Uncertainty Analysis in Engineering

Hotel students must take:

- HADM 2201 Hospitality Quantitative Analysis

All other students can meet this requirement with any one of the following:

- MATH 1710 Statistical Theory and Application in the Real World
- STSCI 2010 Introductory Statistics
- AEM 2100 Introductory Statistics
- PAM 2100 Introduction to Statistics
- HADM 2201 Hospitality Quantitative Analysis
- ENGRD 2700 Basic Engineering Probability and Statistics
- BTRY 3010 Statistical Methods I
- SOC 3010 Evaluating Statistical Evidence
- CEE 3040 Uncertainty Analysis in Engineering
- ILRST 3120 Applied Regression Methods
- ECON 3190 Introduction to Statistics and Probability
- PSYCH 3500 Statistics and Research Design

Human-Centered Systems

- COGST 1101 Introduction to Cognitive Science
- PSYCH 2050 Perception
- INFO 2140 Cognitive Psychology
- INFO 2450 Psychology of Social Computing
- PSYCH 2800 Introduction to Social Psychology
- PSYCH 3420 Human Perception: Applications to Computer Graphics, Art, and Visual Display
- INFO 3450 Human-Computer Interaction Design

- PSYCH 3470 Psychology of Visual Communications
- INFO 3650 Technology in Collaboration
- PSYCH 3800 Social Cognition
- PSYCH 4130 Information Processing: Conscious and Unconscious
- PSYCH 4160 Modeling Perception and Cognition
- INFO 4400 Advanced Human-Computer Interaction Design
- INFO 4450 Seminar in Computer-Mediated Communication
- INFO 4500 Language and Technology
- DEA 4700 Applied Ergonomic Methods

Social Systems

- INFO 2040 Networks
- STS 2501 Technology in Society
- INFO 2921 Inventing an Information Society
- ECON 3010 Microeconomics*
- SOC 3040 Social Networks and Social Processes
- ECON 3130 Intermediate Microeconomic Theory*
- INFO 3200 New Media and Society
- AEM 3220 Technology, Information, and Business Strategy*
- INFO 3490 Media Technologies
- INFO 3551 Computers: From the 17th Century to the Dotcom Boom
- INFO 3561 Computing Cultures
- INFO 3660 History and Theory of Digital Art
- ECON 3680 Game Theory*
- INFO 3871 The Automatic Lifestyle: Consumer Culture and Technology
- STS 4111 Knowledge, Technology, and Property
- INFO 4144 Responsive Environments
- ECON 4190 Economic Decisions Under Uncertainty
- COMM 4280 Communication Law
- INFO 4290 Copyright in the Digital Age
- ORIE 4350 Introduction to Game Theory*
- INFO 4470 Social and Economic Data
- HADM 4489 The Law of the Internet and E-Commerce
- ECON 4760/4770 Decision Theory I and II
- INFO 4850 Computational Methods for Complex Networks
- INFO 5150 Culture, Law, and Politics of the Internet
- HADM 5574 Strategic Information Systems*

*Only one of ECON 3010 and 3130 can be taken for IS credit. Only one of ORIE 4350 and ECON 3680 can be taken for IS credit. Only one of AEM 3220 and HADM 5574 may be taken for IS credit.

Information Systems

- INFO 1301 Introduction to Programming Web Applications

and

- INFO 1302 Introduction to Designing Web Applications* (equivalent to one course)
- INFO 1700 Computation, Information, and Intelligence
- CS 2110 Computers and Programming*
- INFO 2300 Intermediate Design and Programming for the Web*
- CIS 3000 Introduction to Computer Game Design
- INFO 3300 Data-Driven Web Applications
- INFO 4300 Information Retrieval
- INFO 4302 Web Information Systems
- CS 4320 Introduction to Database Systems
- LING 4424 Computational Linguistics
- LING 4474 Introduction to Natural Language Processing
- CS 4620 Introduction to Computer Graphics
- CS 4700 Foundations of Artificial Intelligence
- ORIE 4740 Statistical Data Mining I
- CS 4780 Machine Learning
- ORIE 4800 Information Technology
- ORIE 4810 Delivering OR Solutions with Information Technology
- ORIE 4850 Application of Operations Research and Game Theory to Information Technology
- CS 5150 Software Engineering
- INFO 5300 Architecture of Large-Scale Information Systems
- CS 5430 System Security
- ECE 5620 Fundamental Information Theory
- CS 5780 Empirical Methods in Machine Learning and Data Mining

*The following exceptions apply:

- INFO 1301 and 1302: Engineering students and Computer Science majors may not use these courses for the minor.
- INFO 2300: Computer Science majors may not use this course for the minor.
- CS 2110: Students for whom this is a required major course may not use it for the minor, e.g., Computer Science or Operations Research and Information Engineering majors.

COMPUTING AND INFORMATION SCIENCE (CIS) COURSES

CIS 1121 Introduction to MATLAB (also EAS 1121)
Fall, spring. 2 credits. Corequisite: MATH 1110, 1910, or equivalent. No programming experience assumed.
Introduction to elementary computer programming concepts using MATLAB. Topics include problem analysis, development of algorithms, selection, iteration, functions, and arrays. Examples and assignments are chosen to build an appreciation for computational science. The goal is for each student to develop a facility with MATLAB that will be useful in other courses whenever there is a need for computer problem solving or visualization.

CIS 1610 Computing in the Arts (also CS/ENGRI 1610, DANCE 1540, FILM 1750, MUSIC 1465, PSYCH 1650)
Fall. 3 credits.
For description, see CS 1610.

CIS 1620 Visual Imaging in the Electronic Age (also ARCH 4509, ART 1700, CS/ENGRI 1620)
Fall. 3 credits.
For description, see ART 1700.

CIS 1900 Virtual Worlds
Fall. 4 credits.
Survey covering the technology, design, and application of virtual worlds for education, training, and outreach. Lectures and readings introduce various aspects of computing and information science, including hardware, software, interactive design, usability, social conventions, programming, and security within the context of this new social communication environment. During lab sessions, students serve in teams as online mentors (no travel required) to middle school students in after-school CYFair (CyberYouthFair) programs. These programs focus on participatory, project-based learning using collaborative virtual world environments and online information tools for data analysis and visualization.

CIS 3000 Introduction to Computer Game Design
Spring. 4 credits. Prerequisites: students must satisfy at least one of the following, according to their area of interest (art, music, or programming): Art: ART 2501 or equivalent; Music: CS 111x or INFO 1301–1302, MUSIC 1421 or equivalent; Programming: CS/ENGRD 2110 or equivalent.
Investigates the theory and practice of developing computer games from a blend of technical, aesthetic, and cultural perspectives. Technical aspects of game architecture include software engineering, artificial intelligence, game physics, computer graphics, and networking. Aesthetic and cultural aspects of design include art and modeling, sound and music, history of games, genre analysis, role of violence, gender issues in games, game balance, and careers in the industry. Programmers, artists, and musicians collaborate to produce an original computer game.

CIS 4002 Advanced Projects in Game Design
Spring. 3 credits. Prerequisites: CIS 3000 and permission of instructor.
Project-based follow-up course to CIS 3000. Students work in a multidisciplinary team to develop an original computer game or an application that explores innovative game technology. Students have the goal of submitting their work to a contest or conference. Grading is based on completion of project plans and documentation, teamwork, presentations and demonstrations, class participation, and quality of final projects. Instructional meetings are arranged based on student and instructor schedules.

CIS 4205 Effective Use of High-Performance Computing
Spring, usually weeks 1–7. 2 credits. Prerequisites: proficiency in C, C++, Fortran, or Fortran 90. S-U grades only.
An introduction to high-performance computing (HPC) for graduate students or advanced undergraduate students who will use HPC as a tool in their research. Various HPC architectural platforms are described with a focus on computational clusters. Students learn how to identify and exploit the various types of parallelism in algorithms and legacy applications. Understanding how to measure speedup and efficiency and how various bottlenecks affect them are covered. Parallel programming with MPI, OpenMP, and task-farming techniques such as the use of web services are covered in detail. The goal of the class is for students to gain practical HPC experience for use in their specific fields of research.

CIS 4206 Introduction to Scripting in Python and Perl
Spring, usually weeks 8–14. 2 credits. Prerequisites: basic computer programming skills or permission of instructor. S-U grades only.
Scientific computing today requires heterogeneous systems, software, and data to be used together in many different ways, based on desired results. Researchers commonly develop work-flows that control the processing of data and/or experiments from beginning to the desired results. The "glue" that often links the various stages of these work-flows is scripting languages. In this course we explore scripting with two of the most popular scripting languages, Perl and Python, from the basics to specific types of functions/capabilities that are useful in the development and maintenance of scientific work-flows. Examples are provided for Microsoft Windows, Mac OS X and Red Hat Linux. Best-of-breed modules and tools are covered for each platform based on student interest.

CIS 4999 Independent Reading and Research
Fall, spring. 1–4 credits.
Independent reading and research for undergraduates.

CIS 5040 Applied Systems Engineering (also CEE 5040, SYSEN 5100, ECE/ORIE 5120, MAE 5910)
Fall. 3 credits. Prerequisites: senior or graduate standing in engineering field; concurrent or recent (past two years) enrollment in group-based project with strong system design component approved by course instructor.
For description, see SYSEN 5100.

CIS 5050 Systems Analysis Architecture, Behavior, and Optimization (also CEE 5050, ECE/ORIE 5130, MAE 5920, SYSEN 5200)
Spring. 3 credits. Prerequisite: Applied Systems Engineering (CEE 5240, ECE 5120, MAE 5910, ORIE 5120, or SYSEN 5100).
For description, see SYSEN 5200.

[CIS 5640 Computer Animation (also ART 2703, CS 5640)
Fall. 4 credits. Prerequisite: none. Next offered 2009–2010.
For description, see ART 2703.]

[CIS 5642 Advanced Animation (also ART 3702, CS 5642)
Spring. 4 credits. Prerequisite: none. Next offered 2009–2010.
For description, see ART 3702.]

[CIS 5847 Decision Theory II (also ECON 4770/6770)
Spring. 4 credits. Prerequisite: mathematical sophistication. Next offered 2009–2010.
For description, see ECON 4770.]

CIS 6229 Computational Methods for Nonlinear Systems (also PHYS 7682)
Fall. 4 credits. Enrollment may be limited.
For description, see PHYS 7682.

CIS 7970 Topics in CIS/IGERT Seminars
Fall, spring. 1 credit. S-U grades only.
Discusses diverse topics in nonlinear systems. The seminar is oriented to the requirements for the IGERT Program in Nonlinear Systems, a National Science Foundation–supported graduate training program. Includes a mixture of student, faculty, and visitor presentations and development of plans for internships and student projects.

CIS 7999 Independent Research
Fall, spring. Variable credit. Prerequisite: permission of CIS faculty member.
Independent research or master of engineering project.

COMPUTER SCIENCE

The Department of Computer Science is affiliated with both the College of Arts and Sciences and the College of Engineering. Students in either college may major in computer science. The department is also part of CIS. Its courses are an integral part of CIS's several educational programs.

Consult the following web site for updates made after the publication of *Courses of Study*: www.cs.cornell.edu/courses/listofcscourses/index.htm.

CS 1109 Fundamental Programming Concepts
Summer. 2 credits. Prerequisite: pre-freshman standing or permission of instructor. Credit may not be applied toward engineering degree. S-U grades only.
Designed for students who intend to take CS 111x but are not adequately prepared for it. Basic programming concepts and problem analysis are studied. An appropriate high-level programming language is used. Students with previous programming experience and students who do not intend to take CS 111x should not take this course.

CS 1110 Introduction to Computing Using Java
Fall, spring, summer. 4 credits. Assumes basic high school mathematics (no calculus) but no programming experience.
Programming and problem solving using Java. Emphasizes principles of software development, style, and testing. Topics include object-oriented concepts, procedures and functions, iteration, arrays, strings, algorithms, exceptions, GUIs (graphical user interfaces). Weekly labs provide guided practice on the computer, with staff present to help. Assignments use graphics and GUIs to help develop fluency and understanding.

CS 1112 Introduction to Computing Using MATLAB
Fall, spring. 4 credits. Corequisite: MATH 1110, 1910, or equivalent. Assumes student is comfortable with mathematics (at level of one semester of calculus) but has no prior programming experience.
Programming and problem solving using MATLAB. Emphasizes the systematic development of algorithms and programs. Topics include iteration, functions, arrays, and MATLAB graphics. Assignments are designed to build an appreciation for complexity, dimension, fuzzy data, inexact arithmetic, randomness, simulation, and the role of approximation.

[CS 1113 Introduction to Computer Programming—Honors
Fall or spring. 4 credits.]

[CS 1114 Introduction to Computing Using MATLAB and Robotics
Spring. 4 credits. Prerequisite: some programming experience. Next offered 2009–2010.
Honors-level introduction to computer science using camera-controlled robots using MATLAB. Emphasis is on modular design of programs and on fundamental algorithms. Extensive laboratory experiments with cameras and robots, including Sony Aibo. Example projects include controlling a robot by pointing a light stick and making a robot recognize simple colored objects.]

CS 1130 Transition to Object-Oriented Programming
Fall, spring, summer. 1 credit. Prerequisite: one course in programming. S-U grades only.
Introduction to object-oriented concepts using Java. Assumes programming knowledge in a language like MATLAB, C, C++, or Fortran. Students who have learned Java but were not exposed heavily to OO are welcome.

CS 1132 Transition to MATLAB
Fall, spring. 1 credit. Prerequisite: one course in programming. S-U grades only.
Introduction to MATLAB and scientific computing. Covers the MATLAB environment, assignment, conditionals, iteration, scripts, functions, arrays, scientific graphics, and vectorized computation. Assumes programming knowledge in a language like Java, C, C++, or Fortran.

CS 1301 Introduction to Programming Web Applications
Fall, weeks 1–7. 2 credits. Students must enrol in both CS 1301 and 1302.
For description, see INFO 1301.

CS 1302 Introduction to Designing Web Applications
Fall, weeks 8–14. 2 credis. Students must enroll in both CS 1301 and 1302. Prerequisite: CS 1301 or equivalent knowledge.
For description, see INFO 1302.

CS 1610 Computing in the Arts (also CIS/ENGRI 1610, DANCE 1540, FILM 1750, MUSIC 1465, PSYCH 1650)
Fall. 3 credits. Recommended: good comfort level with computers and some of the arts.
Over the centuries, artists in a wide variety of media have employed many approaches to the creative process, ranging from the philosophical to the mechanical to the virtual. This course unravels some of the mysteries going on inside software used for art and

music. It looks at ways of breaking things apart and sampling and ways of putting things together and resynthesizing, and explores ideas for creation. This course does not teach software packages for creating art and music. The course complements ART 1701+ and MUSIC 1421+.

CS 1620 Visual Imaging in the Electronic Age (also ART 1700, CIS/ENGRI 1620)
Fall. 3 credits.
For description, see ART 1700.

CS 1710 Introduction to Cognitive Science (also COGST 1010, LING 1700, PHIL 1910, PSYCH 1020)
Fall, summer. 3 credits.
For description, see COGST 1101.

CS 2022 Introduction to C
Fall, spring, usually weeks 1–4. 1 credit. Prerequisite: one programming course or equivalent programming experience. Credit granted for both CS 2022 and 2024 only if 2022 taken first. S-U grades only.
Brief introduction to the C programming language and standard libraries. Unix accounts are made available for students wishing to use that system for projects, but familiarity with Unix is not required. Projects may be done using any modern implementation of C. CS 2024 (C++ Programming) includes much of the material covered in 2022. Students planning to take CS 2024 normally do not need to take 2022.

CS 2024 C++ Programming
Fall. 2 credits. Prerequisite: one programming course or equivalent programming experience. Students who plan to take CS 2022 and 2024 must take 2022 first. S-U grades only.
An intermediate introduction to the C++ programming language and the C/C++ standard libraries. Topics include basic statements, declarations, and types; stream I/O; user-defined classes and types; derived classes, inheritance, and object-oriented programming; exceptions and templates. Recommended for students who plan to take advanced courses in computer science that require familiarity with C++ or C. Students planning to take CS 2024 normally do not need to take CS 2022; 2024 includes most of the material taught in 2022.

CS 2026 Introduction to C#
Spring, usually weeks 5–8. 1 credit. Prerequisite: CS/ENGRD 2110 or equivalent experience. S-U grades only.
Introduces students to building applications in the .NET environment using the C# language.

CS 2042 Unix Tools
Fall, usually weeks 5–8. 1 credit. Prerequisite: one programming course or equivalent programming experience. S-U grades only.
Introduction to Unix, emphasizing tools for file management, communication, process control, managing the Unix environment, and rudimentary shell scripts. Projects assume no previous knowledge of Unix or expertise in any particular language.

CS 2044 Advanced UNIX Programming and Tools
Spring, usually weeks 5–8. 1 credit. Prerequisite: CS 2042 or equivalent. S-U grades only.
Focuses on Unix as a programming environment for people with a basic knowledge of Unix and experience programming in at least one language. Projects cover advanced shell scripts (sh, ksh, csh), Makefiles, programming and debugging tools for C and other languages, and more modern scripting languages such as Perl and Python. Students with little or no experience with Unix should take CS 2042 first.

CS 2110 Object-Oriented Programming and Data Structures (also ENGRD 2110)
Fall, spring, summer. 3 credits. Prerequisite: CS 1110, CS 1130, or CS 1113 or CS 1112 if completed before fall 2007 or equivalent course in Java or C++.
Intermediate programming in a high-level language and introduction to computer science. Topics include program structure and organization, object-oriented programming (classes, objects, types, sub-typing), graphical user interfaces, algorithm analysis (asymptotic complexity, big "O" notation), recursion, data structures (lists, trees, stacks, queues, heaps, search trees, hash tables, graphs), simple graph algorithms. Java is the principal programming language.

CS 2111 Programming Practicum
Fall, spring. 1 credit. Pre- or corequisite: CS/ENGRD 2110. Letter grades only.
Project course that introduces students to the ways of software engineering using the Java programming language. The course requires the design and implementation of several large programs.

CS 2300 Intermediate Design and Programming for the Web (also INFO 2300)
Spring. 3 credits. Prerequisite: CS 1301 and 1302 strongly recommended.
For description, see INFO 2300.

CS 2800 Discrete Structures
Fall, spring. 3 credits. Pre- or corequisite: one programming course or permission of instructor.
Covers the mathematics that underlies most of computer science. Topics include mathematical induction; logical proof; propositional and predicate calculus; combinatorics and discrete mathematics; basic probability theory; basic number theory; sets, functions, and relations; partially ordered sets; and graphs. These topics are discussed in the context of applications to many areas of computer science, including game playing, the RSA cryptosystem, data mining, load balancing in distributed systems, properties of the Internet and World Wide Web, and web searching.

CS 2850 Networks (also ECON/INFO 2040, SOC 2090)
Spring. 4 credits. Prerequisites: none.
For description, see ECON 2040.

CS 3110 Data Structures and Functional Programming
Fall, spring. 4 credits. Prerequisite: CS 2110 and 2111 or equivalent programming experience. Pre- or corequisite: CS 2800. Should not be taken concurrently with CS 3410 or 3420.
Advanced programming course that emphasizes functional programming techniques and data structures. Programming topics include recursive and higher-order procedures, models of programming language evaluation and compilation, type systems, and polymorphism. Data structures and algorithms covered include graph algorithms, balanced trees, memory heaps, and garbage collection. Also covers techniques for analyzing program performance and correctness.

CS 3220 Introduction to Scientific Computation (also ENGRD 3220)
Spring, summer. 3 credits. Prerequisites: One programming course and MATH 2210 or 2940, knowledge of discrete probability and random variables at the level of CS 2800.
Introduction to elementary numerical analysis and scientific computation. Topics include interpolation, quadrature, linear and nonlinear equation solving, least-squares fitting, and ordinary differential equations. The MATLAB computing environment is used. Vectorization, efficiency, reliability, and stability are stressed. Includes special lectures on computational statistics.

CS 3300 Data-Driven Web Applications (also INFO 3300)
Spring. 3 credits. Prerequisite: CS/ENGRD 2110. CS majors may use only one of the following toward their degree: CS/INFO 3300 or CS 4321.
For description, see INFO 3300.

CS 3410 Systems Programming
Fall. 4 credits. Prerequisite: CS 2110 or equivalent programming experience. Should not be taken concurrently with CS 3110.
Introduction to systems programming, computer organization, and the hardware/software interface. Topics include representation of information, machine and assembly languages, processor organization, memory management, input/output mechanisms, and basic network programming. Also covered are techniques for analyzing program performance and optimization

CS 3420 Computer Organization (also ECE 3140)
Spring. 4 credits. Prerequisite: CS 2110 or ENGRD 2300. Should not be taken concurrently with CS 3110.
For description, see ECE 3140.

[CS 3700 Explorations in Artificial Intelligence (also INFO 3720)
Spring. 3 credits. Prerequisites: MATH 1110 or equivalent, statistics course, and CS/ENGRD 2110 or permission of instructor. Next offered 2009–2010.
For description, see INFO 3720.]

CS 3740 Computational Linguistics (also COGST 4240, LING 4424)
Fall. 4 credits. Recommended: CS 2042.
For description, see LING 4424.

CS 3810 Introduction to Theory of Computing
Fall, summer. 3 credits. Prerequisite: CS 2800 or permission of instructor.
Introduction to the modern theory of computing: automata theory, formal languages, and effective computability.

[CS 4110 Programming Languages and Logics
Fall. 4 credits. Prerequisite: CS 3110 or permission of instructor. Next offered 2009–2010.
Introduction to the theory, design, and implementation of programming languages.

Topics include operational semantics, type systems, higher-order function, scope, lambda calculus, laziness, exceptions, side effects, continuations, objects, and modules. Also discussed are logic programming, concurrency, and distributed and persistent programming.]

[CS 4120 Introduction to Compilers
Spring. 3 credits. Prerequisites: CS 3110 or permission of instructor and CS 3410 or 3420. Corequisite: CS 4121.
Introduction to the specification and implementation of modern compilers. Topics include lexical scanning, parsing, type checking, code generation and translation, an introduction to optimization, and the implementation of modern programming languages.]

[CS 4121 Practicum in Compilers
Spring. 2 credits. Corequisite: CS 4120.
Compiler implementation project related to CS 4120.]

CS 4210 Numerical Analysis and Differential Equations (also MATH 4250)
Fall. 4 credits. Prerequisites: MATH 2210 or 2940 or equivalent, one additional mathematics course numbered 3000 or above, and knowledge of programming.
For description, see MATH 4250.

CS 4220 Numerical Analysis: Linear and Nonlinear Problems (also MATH 4260)
Spring. 4 credits. Prerequisites: MATH 2210 or 2940 or equivalent, one additional mathematics course numbered 300 or above, and knowledge of programming.
Introduction to the fundamentals of numerical linear algebra: direct and iterative methods for linear systems, eigenvalue problems, singular value decomposition. In the second half of the course, the above are used to build iterative methods for nonlinear systems and for multivariate optimization. Strong emphasis is placed on understanding the advantages, disadvantages, and limits of applicability for all the covered techniques. Computer programming is required to test the theoretical concepts throughout the course.

CS 4300 Information Retrieval (also INFO 4300)
Fall. 3 credits. Prerequisite: CS 2110 or equivalent.
For description, see INFO 4300.

CS 4302 Web Information Systems (also INFO 4302)
Spring. 3 credits. Prerequisites: CS 2110 and some familiarity with web site technology.
For description, see INFO 4302.

CS 4320 Introduction to Database Systems
Fall. 3 credits. Prerequisites: CS 3110 (or CS 2110, 2111, and permission of instructor).
Introduction to modern database systems. Concepts covered include storage structures, access methods, query languages, query processing and optimization, transaction management, recovery, database design, XML, and XQuery. The course focuses on the design and internals of modern database systems.

CS 4321 Practicum in Database Systems
Fall. 2 credits. Pre- or corequisite: CS 4320. CS majors may use only one of the following toward their degree: CS/INFO 3300 or CS 4321.
Students build part of a real database system in C++.

CS 4410 Operating Systems
Spring. 3 credits. Prerequisite: CS 3410 or 3420.
Introduction to the logical design of systems programs, with emphasis on multiprogrammed operating systems. Topics include process synchronization, deadlock, memory management, input-output methods, information sharing, protection and security, and file systems. The impact of network and distributed computing environments on operating systems is also discussed.

CS 4411 Practicum in Operating Systems
Spring. 2 credits. Corequisite: CS 4410.
Studies the practical aspects of operating systems through the design and implementation of an operating system kernel that supports multiprogramming, virtual memory, and various input-output devices. All the programming for the project is in a high-level language.

CS 4420 Computer Architecture (also ECE 4750)
Fall. 4 credits. Prerequisites: ENGRD 2300 and CS 3420/ECE 3140.
For description, see ECE 4750.

CS 4450 Computer Networks
Spring. 4 credits. Pre- or corequisite: CS 4410 or permission of instructor.
Introduction to computer networks with an emphasis on fundamentals. Detailed introduction to networking protocols for reliable data transfer, flow control, congestion control, naming and addressing, routing, and security. Fundamentals of layered protocols and techniques for protocol design and implementation. Course material is supplemented by network measurement projects, protocol simulations, and a substantial protocol implementation project running over sockets that requires use of C or C++.

CS 4520 Introduction to Bioinformatics
Spring. 4 credits. Prerequisites: CS/ENGRD 2110, CS 2800.
Overview of the goals, tools, and techniques used in bioinformatics, a field that applies ideas from computer science, mathematical modeling, and statistics in order to make sense of the huge datasets that typify modern biology. Topics include a brief introduction to molecular biology, DNA sequencing, sequence alignment and multiple alignment, similarity searches and their statistics, phylogeny, gene regulation and motif finding, gene finding, and genome rearrangements. Much of the course is devoted to an in-depth study of the algorithms behind popular computational tools such as Smith-Waterman, BLAST, CLUSTALW, Genscan, and MEME.

CS 4620 Introduction to Computer Graphics (also ARCH 3704)
Fall. 4 credits. Prerequisite: CS/ENGRD 2110.
Introduction to the principles of computer graphics in two and three dimensions. Topics include digital images, filtering and anti-aliasing, 2-D and 3-D affine geometry, ray tracing, perspective and 3-D viewing, the graphics pipeline, curves and surfaces, and human visual perception. Homework assignments require some Java programming. May be taken with or without concurrent enrollment in CS 4621.

CS 4621 Computer Graphics Practicum
Fall. 2 credits. Pre- or corequisite: CS 4620.
Provides CS 4620 students with hands-on experience in computer graphics programming on modern graphics hardware. A semester-long project involves building a substantial interactive 3D system. The course uses Java and OpenGL for code development.

CS 4700 Foundations of Artificial Intelligence
Fall. 3 credits. Prerequisites: CS/ENGRD 2110 and CS 2800 (or equivalent).
Challenging introduction to the major subareas and current research directions in artificial intelligence. Topics include knowledge representation, heuristic search, problem solving, natural-language processing, game-playing, logic and deduction, planning, and machine learning.

CS 4701 Practicum in Artificial Intelligence
Fall. 2 credits. Pre- or corequisite: CS 4700.
Project portion of CS 4700. Topics include knowledge representation systems, search procedures, game-playing, automated reasoning, concept learning, reinforcement learning, neural nets, genetics algorithms, planning, and truth maintenance.

CS 4702 Artificial Intelligence: Uncertainty and Multi-Agent Systems
Spring. 4 credits. Prerequisites: CS/ENGRD 2110 and CS 2800 or equivalent.
A key issue in the design of intelligent systems is how to deal with uncertain or incomplete information, as obtained, for example, through (noisy) sensory input. The first half of this course focuses on how to represent and reason with uncertain information. The second half covers the study and design of multi-agent systems. Topics include Bayesian networks, dynamic Bayesian networks, belief propagation, Markov random fields, exact and approximate probabilistic inference methods, Markov Chain Monte Carlo methods, connections to statistical physics and information science, adversarial reasoning and planning in multi-agent systems, and game theoretic notions underlying multi-agent systems. This course complements CS 4700 but is given as a self-contained unit.

CS 4740 Introduction to Natural Language Processing (also COGST 4740, LING 4474)
Spring. 4 credits. Prerequisite: CS 2110.
Computationally oriented introduction to natural language processing, the goal of which is to enable computers to use human languages as input, output, or both. Possible topics include parsing, grammar induction, information retrieval, and machine translation.

[CS 4780 Machine Learning
Spring. 4 credits. Prerequisites: CS 2100, CS 2800, or basic probability theory and basic knowledge of linear algebra. Next offered 2009-2010.
Machine learning is concerned with the question of how to make computers learn from experience. The ability to learn is not only central to most aspects of intelligent

behavior, but machine learning techniques have become key components of many software systems. For example, machine learning techniques are used to create spam filters, to analyze customer purchase data, and to explore new domains of science. This course introduces the fundamental set of techniques and algorithms that constitute machine learning as of today, including classification methods like decision trees and support vector machines, parametric Bayesian learning and hidden Markov models, as well as unsupervised learning and reinforcement learning. The course discusses algorithms and methods and provides an introduction to the theory of machine learning.]

CS 4782 Probabilistic Graphical Models (also BTRY 4790)
Fall. 4 credits. Prerequisites: probability theory (BTRY 4080 or equivalent), programming and data structures (CS 2110 or equivalent); course in statistical methods recommended but not required (BTRY 4090 or equivalent).
For description, see BTRY 4790.

[CS 4812 Quantum Computation (also PHYS 4481/7681)
Spring. 2 credits. Prerequisite: familiarity with theory of vector spaces over complex numbers. Next offered 2009–2010.
For description, see PHYS 4481.]

CS 4820 Introduction to Analysis of Algorithms
Spring, summer. 4 credits. Prerequisites: CS 2800 and 3110.
Develops techniques used in the design and analysis of algorithms, with an emphasis on problems arising in computing applications. Example applications are drawn from systems and networks, artificial intelligence, computer vision, data mining, and computational biology. This course covers four major algorithm design techniques (greedy algorithms, divide-and-conquer, dynamic programming, and network flow), computational complexity focusing on NP-completeness, and algorithmic techniques for intractable problems (including identification of structured special cases, approximation algorithms, and local search heuristics).

CS 4830 Introduction to Cryptography
Fall. 4 credits. Prerequisites: CS 2800 (or equivalent), CS 3810 (or mathematical maturity), or permission of instructor.
Introductory course in cryptography. Topics include one-way functions, encryption, digital signatures, pseudo-random number generation, zero-knowledge and basic protocols. Emphasizes fundamental notions and constructions with proofs or security based on precise definitions and assumptions.

CS 4850 Mathematical Foundations for the Information Age
Spring. 4 credits. Prerequisite: CS 3810.
Covers the mathematical foundation underlying modeling and searching of the web and other complex networks, discovering trends, data mining, and making recommendations based on user behavior. Topics include random graphs; tail bounds; branching processes; spectral analysis; clustering; learning mixtures of distributions; extracting information from large, high dimensional, and noisy data; VC dimension; latent semantic indexing; and collaborative filtering.

CS 4860 Applied Logic (also MATH 4860)
Spring. 4 credits. Prerequisites: MATH 2220 or 2940, CS 2800 or equivalent (e.g., MATH 3320, 4320, 4340, 4810), and some additional course in mathematics or theoretical computer science.
Propositional and predicate logic, compactness and completeness by tableaux, natural deduction, and resolution. Equational logic. Herbrand Universes and unification. Rewrite rules and equational logic, Knuth-Bendix method, and the congruence-closure algorithm and lambda-calculus reduction strategies. Topics in Prolog, LISP, ML, or Nuprl. Applications to expert systems and program verification.

CS 4999 Independent Reading and Research
Fall, spring. 1–4 credits.
Independent reading and research for undergraduates.

CS 5150 Software Engineering
Spring. 4 credits. Prerequisite: CS 2110 or equivalent experience programming in Java or C++.
Introduction to the practical problems of specifying, designing, and building large, reliable software systems. Students work in teams on projects for real clients. This work includes a feasibility study, requirements analysis, object-oriented design, implementation, testing, and delivery to the client. Additional topics covered in lectures include professionalism, project management, and the legal framework for software development.

CS 5300 The Architecture of Large-Scale Information Systems (also INFO 5300)
Spring. 4 credits. Prerequisite: CS/INFO 3300 or CS 4320.
For description, see INFO 5300.

CS 5410 Intermediate Computer Systems
Fall or spring. 4 credits. Prerequisite: CS 4410 or permission of instructor. Next offered fall 2008
Focuses on practical issues in designing and implementing distributed software. Topics vary depending on instructor. Recent offerings have covered object-oriented software development methodologies and tools, distributed computing, fault-tolerant systems, and network operating systems or databases. Students undertake a substantial software project. Many students obtain additional project credit by co-registering in CS 4999 or 7999.

CS 5420 Parallel Computer Architecture (also ECE 5720)
Fall. 4 credits. Prerequisite: ECE 4750.
For description, see ECE 5720.

CS 5430 System Security
Fall or spring. 4 credits. Prerequisites: CS 4410 or 4450 and familiarity with JAVA, C, or C# programming languages. Next offered spring 2009
Discusses security and survivability for computers and communications networks. Includes discussions of policy issues (e.g., the national debates on cryptography policy) as well as discussions of the technical alternatives for implementing the properties that comprise "trustworthiness" in a computing system. Covers mechanisms for authorization and authentication as well as cryptographic protocols.

CS 5450 Advanced Computer Networks (also CS 6450)
Fall or spring. 4 credits. Prerequisite: CS 4450 or permission of instructor. Offered fall 2008.
Examines advanced computer network topics such as overlay and P2P networking, reliable multicast, mobility, voice-over IP, header compression, security, and extreme networking environments (fast, slow, big, long). Emphasizes both research and the latest standards. A project with research content is required. (CS 5450 is for M.Eng. students; CS 6450 for Ph.D. students.)

[CS 5620 Interactive Computer Graphics
Spring. 4 credits. Prerequisite: CS 4620. Next offered 2009–2010.
Methods for interactive computer graphics, targeting applications including games, visualization, design, and immersive environments. Topics include programming graphics processing units (GPUs), shading models, advanced texturing, shadow algorithms, advanced lighting, hierarchical acceleration structures, and animation.]

[CS 5640 Computer Animation (also ART 2703, CIS 5640)
Fall. 4 credits. Prerequisites: none. Next offered 2009–2010.
For description, see ART 2703.]

[CS 5642 Advanced Animation (also ART 3702, CIS 5642)
Spring. 4 credits. Prerequisites: none. Next offered 2009–2010.
For description, see ART 3702.]

CS 5643 Physically Based Animation for Computer Graphics
Spring. 4 credits. Prerequisites: CS/ENGRD 3220 and/or CS 4620 or permission of instructor. Offered alternate years.
Modern computer animation and interactive digital entertainment are making increasingly sophisticated use of tools from scientific and engineering computing. This course introduces students to common physically based modeling techniques for animation of virtual characters, fluids and gases, rigid and deformable solids, and other systems. Aspects of interactive simulation and multi-sensory feedback are also discussed. A hands-on programming approach is taken, with an emphasis on small interactive computer programs.

[CS 5722 Heuristic Methods for Optimization (also CEE 5290, ORIE 5340)
Fall or spring. 3 or 4 credits. Prerequisites: CS/ENGRD 2110 or 3220 or CEE/ENGRD 3200, or graduate standing, or permission of instructor. Next offered 2009–2010.
For description, see CEE 5290.]

[CS 5780 Empirical Methods in Machine Learning and Data Mining
Fall or spring. 4 credits. Prerequisites: CS 2800 and 3110 or equivalent. Next offered 2009–2010.
This implementation-oriented course presents a broad introduction to current algorithms and approaches in machine learning, knowledge discovery, and data mining and their application to real-world learning and decision-making tasks. The course also covers experimental methods for comparing learning

algorithms, for understanding and explaining their differences, and for exploring the conditions under which each is most appropriate.]

CS 5846 Decision Theory I (also ECON 4760/6760)
Fall. 4 credits. Prerequisite: mathematical sophistication.
For description, see ECON 4760.

CS 6110 Advanced Programming Languages
Spring. 4 credits. Prerequisite: graduate standing or permission of instructor.
Study of programming paradigms: functional, imperative, concurrent, and logic programming. Models of programming languages, including the lambda calculus. Type systems, polymorphism, modules, and other object-oriented constructs. Program transformations, programming logic, and applications to programming methodology.

[CS 6210 Matrix Computations
Fall. 4 credits. Prerequisites: MATH 4110 and 4310 or permission of instructor. Offered alternate years; next offered 2009–2010.
Stable and efficient algorithms for linear equations, least squares, and eigenvalue problems. Direct and iterative methods are considered. The MATLAB system is used extensively.]

CS 6220 Sparse Matrix Computations
Fall. 4 credits. Prerequisite: CS 6210.
Methods for large sparse matrix problems. Krylov subspace techniques are featured, e.g., conjugate gradients, Lanczos, Arnoldi. Applications from differential equations and optimization methods based on random sampling are also covered. Assignments in Matlab.

[CS 6240 Numerical Solution of Differential Equations
Spring. 4 credits. Prerequisites: exposure to numerical analysis (e.g., CS 4210 or 6210) and differential equations, and knowledge of MATLAB.]

CS 6320 Database Management Systems
Spring. 4 credits. Prerequisite: CS 4320 or permission of instructor.
Covers a variety of advanced issues ranging from transaction management to query processing to data mining. Involves extensive paper reading and discussion. Development of a term project with research content is required.

CS 6322 Advanced Database Systems
Fall. 4 credits.
Covers advanced topics in database systems and data mining. The exact set of topics changes with each offering of the course.

CS 6410 Advanced Systems
Fall or spring. 4 credits. Prerequisite: CS 4410 or permission of instructor. Offered fall 2008.
Advanced course in systems, emphasizing contemporary research in distributed systems. Topics may include communication protocols, consistency in distributed systems, fault-tolerance, knowledge and knowledge-based protocols, performance, scheduling, concurrency control, and authentication and security issues.

CS 6450 Research in Computer Networks
Fall. 4 credits. Prerequisite: CS 4450 or permission of instructor. Offered fall 2008.
Examines advanced computer network topics such as overlay and P2P networking, reliable multicast, mobility, voice over IP, header compression, security, and extreme networking environments (fast, slow, big, long). The emphasis is on both research and the latest standards. A project with research content is required. CS 6450 is for Ph.D. students; CS 5450 is for M.Eng. students.

[CS 6460 Peer-to-Peer Systems
Spring. 4 credits. Recommended: CS 6410. Next offered 2009–2010.]

CS 6522 Biological Sequence Analysis
Fall. 4 credits. Prerequisites: none.
Typically concentrates on one topic in biological sequence analysis, providing an in-depth analysis of the algorithmic and statistical challenges in that area. The selected topics vary from year to year.

CS 6620 Advanced Interactive Graphics
Fall or spring. 4 credits. Prerequisites: CS 4620 and 4621 or 5620 or permission of instructor.
State-of-the-art techniques for high-quality rendering in graphics. Focus on practical rendering algorithms that have had (or are poised to have) big impact in industry. Covers core rendering techniques used in simulation, games, and movies. Topics include photon mapping, environment map lighting, precomputed radiance transfer, radiosity, scalable rendering, GPU global illumination including shadow algorithms, hierarchical acceleration structures, interactive ray tracing on modern architectures including multicore processors and GPUs, cinematic relighting for movie rendering, and perceptually based rendering. Focus is on practical rendering algorithms for graphics applications.

[CS 6630 Realistic Image Synthesis
Fall or spring. 4 credits. Prerequisites: CS 4620 or equivalent and undergraduate-level understanding of algorithms, probability and statistics, vector calculus, and programming.
Advanced course in realistic image synthesis, focusing on the computation of physically accurate images. Topics include radiometry; Monte Carlo methods, models for light reflection from surfaces and scattering in volumes, and algorithms for global illuminations.]

CS 6650 Computational Motion
Fall. 4 credits. Prerequisites: undergraduate-level understanding of algorithms, and some scientific computing. Offered alternate years.
Covers computational aspects of motion, broadly construed. Topics include the computer representation, modeling, analysis, and simulation of motion, and its relationship to various areas, including computational geometry, mesh generation, physical simulation, computer animation, robotics, biology, computer vision, acoustics, and spatio-temporal databases. Students implement several of the algorithms covered in the course and complete a final project.

[CS 6670 Machine Vision
Fall or spring. 4 credits. Prerequisites: undergraduate-level understanding of algorithms and MATH 2210 or equivalent. Next offered spring 2010.
Introduction to computer vision, with an emphasis on discrete optimization algorithms and on applications in medical imaging. Topics include edge detection, image segmentation, stereopsis, motion and optical flow, active contours, and the Hausdorff distance. Students are required to implement several of the algorithms covered in the course and complete a final project.]

[CS 6700 Advanced Artificial Intelligence
Spring. 4 credits. Prerequisites: CS 4700 or permission of instructor. Next offered 2009–2010.
Artificial intelligence (AI) provides many computational challenges. This course covers a variety of areas in AI, including knowledge representation, automated reasoning, learning, game-playing, and planning, with an emphasis on computational issues. Specific topics include stochastic reasoning and search procedures, properties of problem encodings, issues of syntax and semantics in knowledge representation, constraint satisfaction methods and search procedures, and critically constrained problems and their relation to phase-transition phenomena. In addition, connections between artificial intelligence and other fields, such as statistical physics, operations research, and cognitive science are explored.]

CS 6740 Advanced Language Technologies (also INFO 6300)
Fall or spring. 3 credits. Prerequisite: permission of instructor. Neither CS 4300 nor CS 4740 are prerequisites. Offered fall 2008.
Graduate-level introduction to technologies for the computational treatment of information in human-language form, covering modern natural-language processing (NLP) and/or information retrieval (IR). Possible topics include latent semantic analysis (LSI), clickthrough data for web search, language modeling, text categorization and clustering, information extraction, computational syntactic and semantic formalisms, grammar induction, and machine translation.

[CS 6764 Reasoning about Knowledge
Fall. 4 credits. Prerequisites: mathematical maturity and acquaintance with propositional logic. Next offered 2010–2011.
Knowledge plays a crucial role in distributed systems, game theory, and artificial intelligence. Material examines formalizing reasoning about knowledge and the extent to which knowledge is applicable to those areas. Issues include common knowledge, knowledge-based programs, applying knowledge to analyzing distributed systems, attainable states of knowledge, modeling resource-bounded reasoning, and connections to game theory.]

[CS 6766 Reasoning about Uncertainty
Fall. 4 credits. Prerequisites: mathematical maturity and acquaintance with propositional logic. Next offered 2009–2010.
Examines formalizing reasoning about and representing uncertainty, using formal logical approaches as a basis. Topics: logics of

probability, combining knowledge and probability, probability and adversaries, conditional logics of normality, Bayesian networks, qualitative approaches to uncertainty, going from statistical information to degrees of belief, and decision theory.]

[CS 6780 Advanced Topics in Machine Learning
Fall or spring. 4 credits. Prerequisites: CS 4780 or equivalent, or CS 5780 or equivalent, or permission of instructor. Next offered 2009–2010.
Extends and complements CS 4780 and 5780, giving in-depth coverage of new and advanced methods in machine learning. In particular, we connect to open research questions in machine learning, giving starting points for future work. The content of the course reflects an equal balance between learning theory and practical machine learning, making an emphasis on approaches with practical relevance. Topics include support vector machines, clustering, Bayes nets, boosting, model selection, learning orderings, and inductive transfer.]

CS 6782 Probabilistic Graphical Models (also BTRY 6790)
Fall. 4 credits. Prerequisites: probability theory (BTRY 4080 or equivalent), programming and data structures (CS 2110 or equivalent); a course in statistical methods is recommended but not required (BTRY 4090 or equivalent).
For description, see BTRY 6790.

CS 6810 Theory of Computing
Spring. 4 credits. Prerequisites: CS 3810 and CS 4820 or 6820 or permission of instructor.
Advanced treatment of theory of computation, computational-complexity theory, and other topics in computing theory.

CS 6820 Analysis of Algorithms
Fall. 4 credits. Prerequisite: CS 4820 or graduate standing.
Methodology for developing and analyzing efficient algorithms. Understanding the inherent complexity of natural problems via polynomial-time algorithms, advanced data structures, randomized algorithms, approximation algorithms, and NP-completeness. Additional topics may include algebraic and number theoretic algorithms, circuit lower bounds, online algorithms, or algorithmic game theory.

CS 6822 Advanced Topics in Theory of Computing
Fall or spring. 4 credits. Prerequisite: CS 6810, 6820, or 6830 recommended, depending on the topic. Next offered spring 2009.
An advanced study of current topics in the theory of computing. Topics may include algorithms, complexity, logic, cryptography, or theories of networks, information, and learning. Course may be repeated for credit.

CS 6830 Cryptography
Fall. 4 credits. Prerequisites: general ease with algorithms and elementary probability theory, maturity with mathematical proofs (ability to read and write mathematical proofs).
Graduate introduction to cryptography. Topics include encryption, digital signatures, pseudo-random number generation, zero-knowledge, and basic protocols. Emphasizes fundamental concepts and proof techniques.

[CS 6840 Algorithmic Game Theory
Fall or spring. 4 credits. Prerequisite: background in algorithms and graphs at level of CS 4820. No prior knowledge of game theory or economics assumed. Next offered 2009–2010.
Algorithmic game theory combines algorithmic thinking with game-theoretic or, more generally, economic concepts. This course focuses on problems arising from, and motivated by, the Internet and other decentralized computer networks. The most defining characteristic of the Internet is that it was not designed by a single central entity, but emerged from the complex interaction of many economic agents, such as network operators, service providers, designers, and users, in varying degrees of collaboration and competition. The course focuses on some of the many questions at the interface between algorithms and game theory that arise from this point of view. Topics include Nash equilibrium and general equilibrium, the price of anarchy, market equilibrium, social choice theory, mechanism design, and multicast pricing.]

CS 6850 The Structure of Information Networks (also INFO 6850)
Fall or spring. 4 credits. Prerequisite: CS 4820.
For description, see INFO 6850.

CS 7090 Computer Science Colloquium
Fall, spring. 1 credit. For staff, visitors, and graduate students interested in computer science. S-U grades only.
Weekly meeting for the discussion and study of important topics in the field.

CS 7190 Seminar in Programming Languages
Fall, spring. 4 credits. Prerequisite: CS 6110 or permission of instructor. S-U grades only.

CS 7192 Seminar in Programming Refinement Logics
Fall, spring. 4 credits. Prerequisite: permission of instructor.
Topics in programming logics, possibly including type theory, constructive logic, decision procedures, heuristic methods, extraction of code from proofs, and the design of proof-development and problem-solving systems.

CS 7320 Topics in Database Systems
Fall, spring. 4 credits. S-U grades only.

CS 7390 Database Seminar
Spring. 1 credit. Prerequisite: CS 6322 or permission of instructor. S-U grades only.

CS 7410 Topics in Systems
Fall or spring. 3 credits. Prerequisite: permission of instructor.

CS 7490 Systems Research Seminar
Fall, spring. 1 credit. S-U grades only.

CS 7690 Computer Graphics Seminar
Fall, spring. 3 credits.

CS 7726 Evolutionary Computation and Design Automation (also MAE 6500)
Fall. 4 credits. Prerequisite: programming experience or permission of instructor.
Seminar course in evolutionary algorithms and their application to optimization and open-ended computational design. Genetic algorithms, genetic programming, co-evolution, arms races and cooperation, developmental representations, learning, and symbiosis are covered. Topics include artificial life, evolutionary robotics, and applications in a variety of domains in science and engineering. Suitable for students interested in computational techniques for addressing open-ended design problems and in computational models of evolutionary discovery.

CS 7790 Seminar in Artificial Intelligence
Fall, spring. 4 credits. Prerequisite: permission of instructor. S-U grades only.

CS 7794 Seminar in Natural Language Understanding
Fall, spring. 2 credits.
Informal weekly seminar in which current topics in natural language understanding and computational linguistics are discussed.

CS 7890 Seminar in Theory of Algorithms and Computing
Fall, spring. 4 credits. Prerequisite: permission of instructor. S-U grades only.

CS 7999 Independent Research
Fall, spring. Prerequisite: permission of a computer science advisor.
Independent research or master of engineering project.

CS 9999 Thesis Research
Fall, spring. Prerequisite: permission of a computer science advisor. S-U grades only.
Doctoral research.

INFORMATION SCIENCE (INFO)

INFO 1301 Introduction to Programming Web Applications
Fall, weeks 1–7. 2 credits. Students must enroll in both INFO 1301 and 1302.
Building functional and effective web sites that support users' needs and capabilities requires a mixture of technical, design, and analytical skills. This course lays the foundation for proficient web design by covering the technical skills involved, including xHTML, the markup language used to encode web pages, and PHP, a programming language for building interactive web sites. This is an introductory programming course, and no programming background is assumed. Students in 1301 must be co-registered in INFO 1302, which builds on the programming expertise developed in 1301 to develop web design and usability skills.

INFO 1302 Introduction to Designing Web Applications
Fall, weeks 8–14. 2 credits. Students must enroll in both INFO 1301 and 1302. Prerequisite: successful completion of INFO 1301.
Building functional and effective web sites that support users' needs and capabilities requires a mixture of technical, design, and analytical skills. This course builds on the technical skills developed in INFO 1301 to develop full competency in web design. Students develop design and analytical skills including critical analysis, support for usability, user-centered design, and methods for visual layout. Skills will be developed in a studio and project-based format focused on the construction of compelling, functional web sites. To take this course students must either have received a passing grade in INFO 1301, or prove proficiency in PHP programming via a qualifying exam.

INFO 2040 Networks (also ECON 2040, SOC 2120)
Spring. 4 credits.
For description, see ECON 2040.

INFO 2140 Cognitive Psychology (also COGST/PSYCH 2140)
Fall. 4 credits. Limited to 175 students. Prerequisite: sophomore standing. Graduate students, see INFO 6140 or COGST 6150.
For description, see PSYCH 2140.

INFO 2300 Intermediate Design and Programming for the Web (also CS 2300)
Spring. 3 credits. Prerequisite: INFO 1301 and 1302 strongly recommended.
Web programming requires the cooperation of two machines: the one in front of the viewer (client) and the one delivering the content (server). CS 1300 concentrates almost exclusively on the client side. The main emphasis in CS 2300 is learning about server side processing. Students begin by looking at interactions with databases, learning about querying both on paper and via SQL, and then, through a succession of projects, learn how to apply this understanding to the creation of an interactive data-driven site via the use of an integrated web site development tool such as ColdFusion. Also considered are techniques to enhance security, privacy, and reliability and ways of incorporating other programs. Toward the end of the course, students are shown how these development tools are working. Design issues are emphasized. A major component of the course is the creation of a substantial web site.

INFO 2310 Topics in Web Programming and Design
Fall, weeks 1–10. 1 credit. Prerequisite: INFO 2300.
For description, see INFO 2310 in CIS section.

INFO 2450 Psychology of Social Computing (also COMM 2450)
Fall, summer. 3 credits.
For description, see COMM 2450.

INFO 2921 Inventing an Information Society (also AMST/ECE/ENGRG 2980, HIST 2920, STS 2921)
Spring. 3 credits.
For description, see ENGRG 2980.0.

INFO 2950 Mathematical Methods for Information Science
Fall. 4 credits. Corequisite: MATH 2310 or equivalent.
Teaches basic mathematical methods for information science. Topics include graph theory, discrete probability, Bayesian methods, finite automata, Markov models, and hidden Markov models. Uses examples and applications from various areas of information science such as the structure of the web, genomics, natural language processing, and signal processing.

INFO 3200 New Media and Society (also COMM 3200) (CA)
Spring. 3 credits.
For description, see COMM 3200.

INFO 3300 Data-Driven Web Applications (also CS 3300)
Fall. 3 credits. Prerequisite: CS 2110.
Introduces students to modern database systems and three-tier application development with a focus on building web-based applications using database systems. Concepts covered include the relational model, relational query languages, data modeling, normalization, database tuning, three-tier architectures, Internet data formats and query languages, server- and client-side technologies, and an introduction to web services. Students build a database-backed web site.

INFO 3450 Human-Computer Interaction Design (also COMM 3450)
Spring. 3 credits.
For description, see COMM 3450.

INFO 3490 Media Technologies (also COMM 3490, STS 3491)
Spring. 3 credits. Offered odd-numbered years.
For description, see COMM 3490.

INFO 3551 Computers: From the 17th Century to the Dotcom Boom (also STS 3551)
Fall. 4 credits.
For description, see STS 3551.

[INFO 3561 Computing Cultures (also STS 3561)
Spring. 4 credits. No technical knowledge of computer use presumed or required. INFO 3551 and 3561 may be taken separately or in any order. Next offered 2009–2010.
For description, see STS 3561.]

INFO 3650 Technology in Collaboration (also COMM 3650)
Spring. 3 credits. Prerequisite: COMM/INFO 2450.
For description, see COMM 3650.

[INFO 3660 History and Theory of Digital Art (also ARTH 3650) (CA)
Fall. 4 credits. Next offered 2009–2010.
For description, see ARTH 3650.]

[INFO 3720 Explorations in Artificial Intelligence (also CS 3700)
Spring. 3 credits. Prerequisites: MATH 1110 or equivalent, an information science–approved statistics course, and CS 2110 or permission of instructor. Next offered 2009–2010.
How do computers solve tasks as diverse as playing chess or backgammon, control autonomous space missions such as NASA's Deep Space One, plan the route for a driverless car as in the DARPA Grand Challenge race, perform content-based selection of music programs, or solve Sudoku, the latest puzzle craze? This course introduces students to a range of computational modeling approaches and solution strategies using examples from AI and Information Science. Covers different formalisms such as logical representations, constraint-based languages, mathematical programming, and multi-agent approaches (including adversarial games). Emphasis is on modeling, not on algorithms, but efficiency issues (complexity) are highlighted as part of the modeling approaches. Students also learn about the tradeoffs in modeling choices.]

[INFO 3871 The Automatic Lifestyle: Consumer Culture and Technology (also STS 3871)]

[INFO 4144 Responsive Environments (also ARTH 4144) (CA)
Spring. 4 credits. Next offered 2009–2010.
For description, see ARTH 4144.]

[INFO 4290 Copyright in the Digital Age (also COMM 4290)
Fall. 3 credits. Offered odd-numbered years; next offered 2009–2010.
For description, see COMM 4290.]

INFO 4300 Information Retrieval (also CS 4300)
Fall. 3 credits. Prerequisite: CS/ENGRD 2110 or equivalent.
Studies the methods used to search for and discover information in large-scale systems. The emphasis is on information retrieval applied to textual materials, but there is some discussion of other formats. The course includes techniques for searching, browsing, and filtering information and the use of classification systems and thesauruses. The techniques are illustrated with examples from web searching and digital libraries.

INFO 4302 Web Information Systems (also CS 4302)
Spring. 3 credits. Prerequisites: CS 2110 and some familiarity with web site technology.
Examines the architecture of web information systems such as distributed digital libraries and electronic publishing systems. Many of the topics presented are the subject of current research and development at Cornell, other universities, and in standards organizations such as the World Wide Web Consortium. Course content mixes exploration of current tools for building web information systems such as XML, XSLT, and RDF with broader concepts such as techniques for knowledge representation and description, object models for content representation, and legal and economic impacts of web information. A theme that runs throughout the course is the relationship between traditional information environments, exemplified by libraries, and the distributed information environment of the web.

INFO 4350 Seminar on Applications of Information Science (also INFO 6350)
Spring. 3 credits. Prerequisites: background in computing, data structures, and programming at level of CS 2110 or equivalent, and experience using information systems. Undergraduates and master's students should register for INFO 4350; Ph.D. students should register for INFO 6350.
This course brings together the interdisciplinary themes of information science—technological, sociological, legal, economic, and political—through a series of case studies of applications and areas of current research. The case studies are explored through reading and discussion of recent articles on aspects of information science, both social and technical. Many of the case studies build on the Information Science seminar series and on current work at Cornell.

INFO 4400 Advanced Human-Computer Interaction Design (also COMM 4400)
Fall. 3 credits. Prerequisites: COMM/INFO 2450.
For description, see COMM 4400.

[INFO 4450 Seminar in Computer-Mediated Communication (also COMM 4450)
Fall. 3 credits. Prerequisite: COMM/INFO 2450. Next offered 2009–2010.
For description, see COMM 4450.]

INFO 4470 Social and Economic Data (also ILRLE 4470)
Spring. 4 credits. Prerequisites: calculus, IS statistics requirement, and one upper-level social science course, or permission of instructor.
Social and economic data drive decisions in public and private organizations, and quality decisions require quality data. This course focuses on data quality—conceptual fit, sampling and nonsampling error, timeliness, geographic detail, and dissemination—as well as legal and ethical issues in the data manufacturing process. Major emphasis is placed on public use microdata files of the U.S. Census Bureau and their role in the allocation of federal funds. These files include the Census of Population and Housing, Current Population Survey, American Housing Survey, Consumer Expenditure Survey, and American Community Survey. The course is appropriate for upper-level undergraduate, professional master's, and doctoral students who will be users of data products, from the public and private sectors; and/or producers of data products for their organizations, working with existing data products from public and proprietary sources, as well as administrative or survey data collected by their organization.

[INFO 4500 Language and Technology (also COMM 4500)
Spring. 3 credits. Prerequisite: COMM 2450 or permission of instructor. Next offered 2009–2010.
For description, see COMM 4500.]

[INFO 4850 Computational Methods for Complex Networks
Spring. 3 credits. Prerequisites: ECON/INFO 2040/SOC 2090/CS 2850 or equivalent knowledge; CS 2110 or INFO 2300 or equivalent knowledge of basic programming.]

INFO 4900 Independent Reading and Research
Fall, spring. 1–4 credits.
Independent reading and research for undergraduates.

INFO 4910 Teaching in Information Science, Systems, and Technology
Fall, spring. Variable credit.
Involves working as a T.A. in a course in the information science, systems, and technology major.

INFO 5150 Culture, Law, and Politics of the Internet
Fall. 4 credits.
Explores the culture, law, and politics of the Internet. Highlighted issues include: net neutrality, free speech, Internet governance, domain naming, intellectual property, DMCA compliance, privacy and security, and the development of institutional as well as national policy for the Internet.

INFO 5300 The Architecture of Large-Scale Information Systems (also CS 5300)
Spring. 4 credits. Prerequisite: INFO/CS 3300 or CS 4320.
Deals with the architecture of large-scale information systems, with special emphasis on Internet-based systems. Topics include three-tier architectures, edge caches, distributed transaction management, web services, workflows, performance scalability, and high-availability architectures. The course includes a substantial project in the context of three-tier architectures, involving web servers, application servers, and database systems. Students study and use technologies such as Web Services, .Net, J2EE, ASPs, Servlets, XML, and SOAP.

[INFO 6002 Critical Technical Practices]

INFO 6140 Cognitive Psychology (also COGST/PSYCH 6140)
Fall. 4 credits.
For description, see PSYCH 6140.

[INFO 6144 Responsive Environments (also ARTH 6144)
Spring. 4 credits. Next offered 2009–2010.
For description, see ARTH 6144.]

INFO 6300 Advanced Language Technologies (also CS 6740)
Fall or spring. 3 credits. Prerequisites: permission of instructor. Neither INFO/CS 4300 nor CS 4740 are prerequisites. Offered fall 2008.
For description, see CS 6740 in CIS section.

INFO 6350 Seminar on Applications of Information Science (also INFO 4390)
Spring. 3 credits. Prerequisites: background in computing, data structures, and programming at level of CS 2110 or equivalent, and experience using information systems. Undergraduates and master's students should register for INFO 4350; Ph.D. students for INFO 6350.
For description, see INFO 4350.

INFO 6400 Human-Computer Interaction Design (also COMM 6400)
Fall. 3 credits. Prerequisite: graduate standing or permission of instructor.
For description, see COMM 6400.

[INFO 6450 Seminar in Computer-Mediated Communication (also COMM 6450)
Spring. 3 credits. Prerequisite: graduate standing or permission of instructor.
For description, see COMM 6450.]

INFO 6648 Speech Synthesis by Rule (also LING 6648)
Spring. 4 credits. Prerequisite: LING 4401, 4419, or permission of instructor.
For description, see LING 6648.

[INFO 6500 Language and Technology (also COMM 6500)
Spring. 3 credits. Next offered 2009–2010.
For description, see COMM 6500.]

INFO 6850 The Structure of Information Networks (also CS 6850)
Fall or spring. 4 credits. Prerequisite: CS 4820. Offered fall 2008.
Information networks such as the World Wide Web are characterized by the interplay between heterogeneous content and a complex underlying link structure. This course covers recent research on algorithms for analyzing such networks and models that abstract their basic properties. Topics include combinatorial and probabilistic techniques for link analysis, centralized and decentralized search algorithms, generative models for networks, and connections with work in the areas of social networks and citation analysis.

INFO 7090 IS Colloquium
Fall, spring. 1 credit.
For staff, visitors, and graduate students interested in information science.

INFO 7470 Social and Economic Data (GR-RDC) (also ILRLE 7400)
Spring. 4 credits. Prerequisite: Ph.D. and research master's students.
Teaches the basics required to acquire and transform raw information into social and economic data. Covers legal, statistical, computing, and social science aspects of the data "production" process. Major emphasis is placed on U.S. Census data that are accessible from the Census Bureau's Research Data Center network. This version of the course has been specially prepared for graduate students who are planning to use RDC-based data or are seriously considering it. RDC-based data products covered include the new Longitudinal Employer-Household Dynamics (LEHD) micro data; the Longitudinal Business Database (LBD) and its predecessor the Longitudinal Research Database (LRD). Students are introduced to the new NSF-sponsored Virtual Research Data Center. Core topics include: basic statistical principles of populations and sampling frames; acquiring data via samples, censuses, administrative records, and transaction logging; law, economics, and statistics of data privacy and confidentiality protection; data linking and integration techniques; data imputation techniques; and analytic methods for complex linked data sets.

INFO 7900 Independent Research
Fall, spring. Variable credit. Prerequisite: permission of an information science faculty member.
Independent research for M.Eng. students and pre–A exam Ph.D. students.

INFO 9900 Thesis Research
Fall, spring. Variable credit. Prerequisite: permission of an information science faculty member.
Thesis research for post–A exam Ph.D. students.

DEPARTMENT OF STATISTICAL SCIENCE

301 Malott Hall
255-8066

M. T. Wells, chair (301 Malott Hall, 255-4388; R. L. Strawderman, director of graduate studies; J. A. Bunge, director of professional programs; J. Abowd, T. Apanosovich, J. Booth, C. Bustamante, T. DiCiccio, R. Durrett, E. Dynkin, T. Fine, X. Guo, Y. Hong, G. Hooker, J. T. G. Hwang, N. Kiefer, G. Lawler, P. Li, F. Molinari, M. Nielsen, M. Nussbaum, P. Protter, S. Resnick, D. Ruppert, G. Samorodnitsky, S. J. Schwager (undergraduate coordinator), B. Turnbull, P. Velleman, A. Vidyashankar.

STSCI 2010 Introductory Statistics
Fall or spring. 4 credits.
Introduction to the basic concepts of probability, statistics and data analysis. Descriptive methods, normal theory models, and inferential procedures are considered. Topics include basic statistical designs, an introduction to probability, estimation, confidence intervals, tests of significance for a single population mean and proportion, the difference in two population means and proportions, ANOVA, multiple linear regression, and contingency tables.

STSCI 5010–5020 Applied Statistical Analysis

Two-semester core course for students in master of professional studies (M.P.S.) degree program in applied statistics in Department of Statistical Science.

Prerequisite: enrollment in M.P.S. program.

Consists of a series of modules on various topics in applied statistics. Some modules include guest lectures from practitioners. Parallel with the course, students complete a yearlong, in-depth data analysis project.

Fall (STSCI 5010). 4 credits. Letter grades only.

Topics include but are not limited to: statistical computing systems, statistical software packages, data management, statistical graphics, and simulation methods and algorithms.

Spring (STSCI 5020). 4 credits. Letter grades only.

Topics include but are not limited to: sample surveys and questionnaire design, data sources, experimental design, and data mining.

STSCI 6000 Statistics Seminar

Fall and spring. 1 credit. Pre- or corequisite: BTRY 4090 or permission of instructor. S-U grades only.

FACULTY ROSTER

Computing and Information Science (CIS)

Abowd, John, Information Science Program; School of Industrial and Labor Relations
Albonesi, David, School of Electrical and Computer Engineering
Arms, William, Dept. of Computer Science; Information Science Program
Bailey, Graeme, Dept. of Computer Science; Computing in the Arts Program
Bala, Kavita, Dept. of Computer Science; Program of Computer Graphics
Birman, Kenneth, Dept. of Computer Science
Birnholtz, Jeremy, Information Science Program; Dept. of Communication
Blume, Lawrence, Information Science Program; Dept. of Economics
Booth, James, Dept. of Biological Statistics and Computational Biology
Bruce, Thomas, Information Science Program; Law School
Bunge, John, Dept. of Statistical Science; School of Industrial and Labor Relations
Bustamante, Carlos, Computational Biology Program; Dept. of Biological Statistics and Computational Biology
Cardie, Claire, Dept. of Computer Science; Information Science Program
Clark, Andrew, Computational Biology Program; Dept. of Molecular Biology and Genetics
Constable, Robert, Dept. of Computer Science
Demers, Alan, Dept. of Computer Science
Easley, David, Information Science Program; Dept. of Economics
Edelman, Shimon, Information Science Program; Dept. of Psychology
Ernste, Kevin, Computing in the Arts Program; Dept. of Music
Francis, Paul, Dept. of Computer Science
Friedman, Eric, Computer Science Field; Information Science Program; School of Operations Research and Industrial Engineering
Fuchs, W. Kent, School of Electrical and Computer Engineering
Gay, Geri, Information Science Program; Dept. of Communication
Gehrke, Johannes, Dept. of Computer Science
Gillespie, Tarleton, Information Science Program; Dept. of Communication
Ginsparg, Paul, Information Science Program; Dept. of Physics
Gomes, Carla, Dept. of Computer Science; Dept. of Applied Economics and Management
Greenberg, Donald, Dept. of Computer Science; Program of Computer Graphics; Johnson Graduate School of Management; Dept. of Architecture
Gries, David, Dept. of Computer Science; College of Engineering
Haas, Zygmunt, Computer Science Field; School of Electrical and Computer Engineering
Halpern, Joseph, Dept. of Computer Science; Information Science Program
Hancock, Jeff, Information Science Program; Dept. of Communication
Hartmanis, Juris, Dept. of Computer Science
Hemami, Sheila, Computer Science Field; School of Electrical and Computer Engineering
Hopcroft, John, Dept. of Computer Science
Huttenlocher, Daniel, Dept. of Computer Science; Information Science Program; Johnson Graduate School of Management
James, Doug, Dept. of Computer Science; Program of Computer Graphics
Joachims, Thorsten, Dept. of Computer Science; Information Science Program
Kedem, Klara, Dept. of Computer Science; Computational Biology Program
Keich, Uri, Dept. of Computer Science; Computational Biology Program
Kleinberg, Jon, Dept. of Computer Science; Computational Biology Program; Information Science Program
Kleinberg, Robert, Dept. of Computer Science
Koch, Christoph, Dept. of Compuer Science
Kozen, Dexter, Dept. of Computer Science
Lee, Lillian, Dept. of Computer Science; Information Science Program
Li, Ping, Dept. of Statistical Science
Lipson, Hod, Computing and Information Science Program; School of Mechanical and Aerospace Engineering
Macy, Michael, Information Science Program; Dept. of Sociology
Manohar, Rajit, Computer Science Field; School of Electrical and Computer Engineering
Marschner, Steve, Dept. of Computer Science; Program of Computer Graphics
Martinez, Jose, Computer Science Field; School of Electrical and Computer Engineering
Myers, Andrew, Dept. of Computer Science
Nerode, Anil, Computer Science Field; Dept. of Mathematics
Nussbaum, Michael, Dept. of Statistical Science; Dept. of Mathematics
Pass, Rafael, Dept. of Computer Science
Pinch, Trevor, Information Science Program; Dept. of Science and Technology Studies
Prentice, Rachel, Information Science Program; Dept. of Science and Technology Studies
Rooth, Mats, Information Science Program; Dept. of Linguistics
Schneider, Fred, Dept. of Computer Science
Selman, Bart, Dept. of Computer Science
Sengers, Phoebe, Information Science Program; Dept. of Science and Technology Studies
Shmoys, David, Dept. of Computer Science; School of Operations Research and Industrial Engineering
Siepel, Adam, Computational Biology Program; Dept. of Biological Statistics and Computational Biology
Sirer, Emin Gun, Dept. of Computer Science
Spivey, Michael, Information Science Program; Dept. of Psychology
Suh, G. Edward, School of Electrical and Computer Engineering
Tardos, Eva, Dept. of Computer Science; Information Science Program
Teitelbaum, Tim, Dept. of Computer Science
Thurston, William, Computing and Information Science Program; Dept. of Mathematics
Van Loan, Charles, Dept. of Computer Science; Computational Science and Engineering Program
Vidyashankar, Anand, Dept. of Statistical Science; School of Industrial and Labor Relations
Wells, Martin, Dept. of Statistical Science; Computational Biology Program
Wicker, Stephen, Computer Science Field; School of Electrical and Computer Engineering
Williamson, David, Information Science Program; School of Operations Research and Industrial Engineering
Yuan, Connie, Information Science Program; Dept. of Communication
Zabih, Ramin, Dept. of Computer Science